

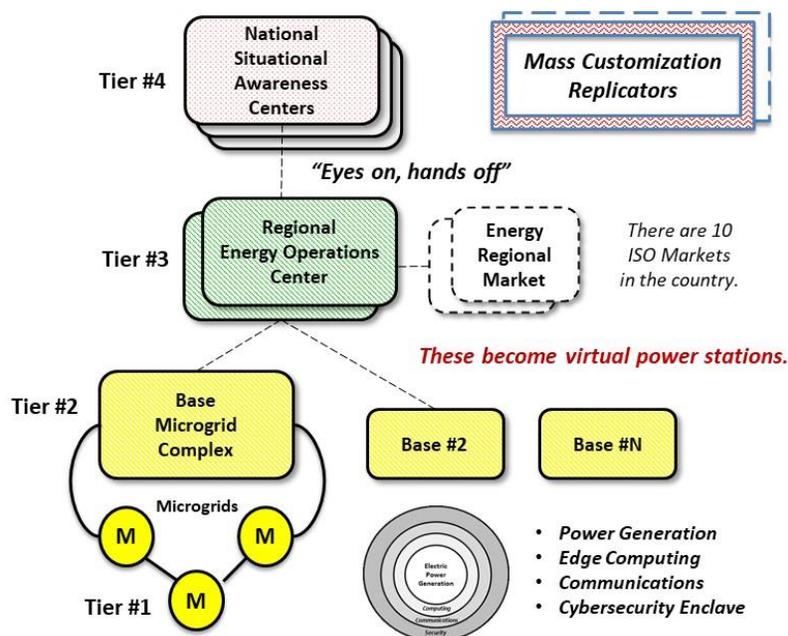
## Anatomy of the Tier-2 Cluster Node Smart Grid

John Reynolds, CEO, Agile Fractal Grid  
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In the sage advice of master architect Eero Saarinen, “One should never attempt to design a thing without first understanding at least the next greater context into which it must fit.” Thus, we begin with a discussion of the greater context of what we will define as a “Tier-2 Cluster Node.”

As described in the Smart Grid vertical of the TM Forum Catalyst on the Digital Business marketplace, there are four tiers to a national rollout of a decentralized approach to operating the new smart electric power grid. For proper sensitivity, urgent decisions are delegated to the smart edges for real-time management, and then in laminar fashion, every layer receives guidance from above, and also reports upward its decisions for a shared consciousness with a graceful collaboration.

One such approach being contemplated for implementation in the United States is illustrated in the following diagram.

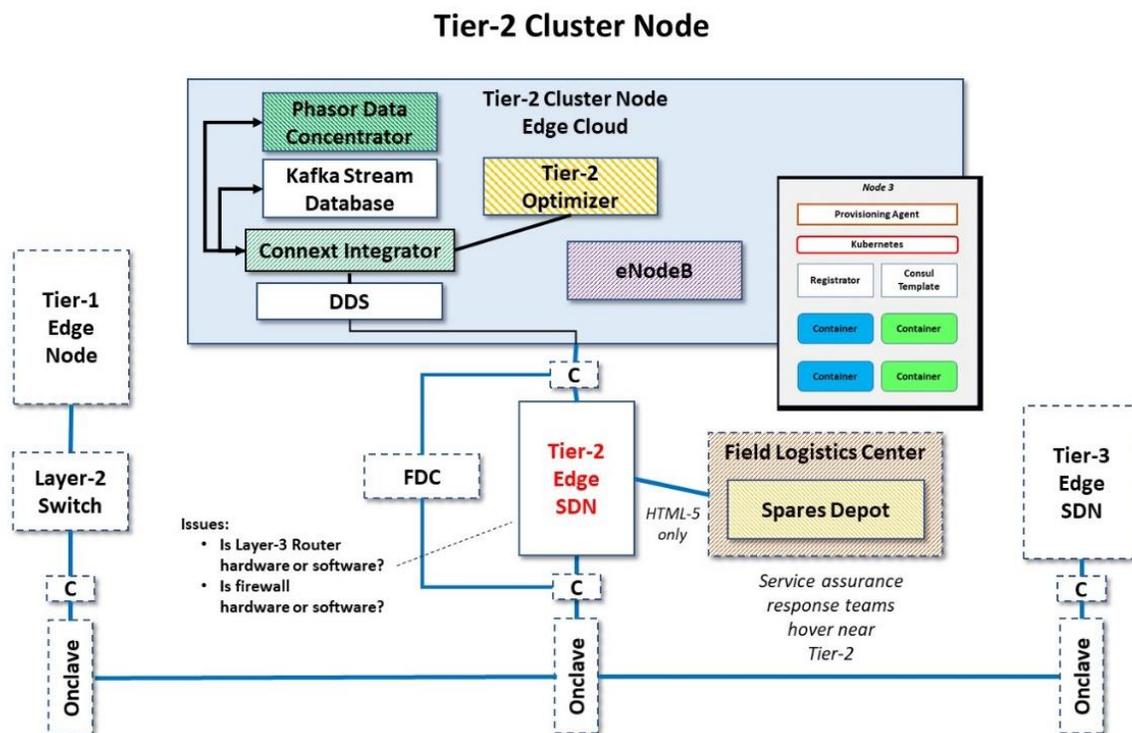


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In this approach, each end point at the bottom of the structure at Tier-1 can generate its own power. It provides for communications as a cellular node. It has its own computing power for local decisions and controls. And each end node is its own cyber enclave, allowing for continued security even if operating in “islanded” mode cut off from the rest of the world. For most resilient operations, there will be several microgrids operating as a team. And the fleet of these microgrids will be optimized as a team by one or more Tier-2 Cluster Nodes, or District Pods as they are sometimes called. The Tier-2 Cluster Node provides guidance to the Tier-1 Microgrids, but it also receives financial and operational optimization guidance from a Tier-3 Regional Energy Operations Center.

The internal structure of the Tier-2 Cluster Node is shown in the following diagram.



The Tier-2 Cluster Node receives streams of event notifications from the Tier-1 Edge Nodes as described in other whitepapers<sup>1</sup> It duly captures the events in a streaming log that also functions as a time series Big Data data lake. The volume can be significant.

But the positioning of the Tier-2 Cluster Node is convenient for a lot of other things happening at that location and the surrounding vicinity than just capturing electric power event data. Another function of each fractal node is that it is also a communications hub. The communications can either be wired with optical fiber and such, or it can be wireless for backup communications for the cluster of microgrids, or for the community district in general for mobile communications, public safety communications, or even serving as a fixed communications path serving residences, commercial activities, and industrial purposes in the district. It can be a convenient place for housing the eNodeB for 4G wireless RAN services in the district, or the O-RAN server for similar 5G district operations. In some cases, it may also serve as a mesh communications hub for a small community.

Because of its ability to self-power itself, The Tier-2 Cluster Node location becomes a convenient place to place a very small private cloud system for handling a variety of latency sensitive and mission critical applications for the district because of the proximity to the communications hub and the resilient up-time that the resident power generation and storage of the fractal complex provides. But after careful observation that there will be lots of Tier-2 Cluster Nodes in any form of multi-national unfolding of the fractal architecture for the power grid, a more standards-oriented approach would be to make the Tier-2 Cluster Node a fundamental building block of the pattern for ***Infrastructure as a Service (IaaS)***. As such, we will develop the plan for this building block using already available offerings for this distributed computing element such that we can begin modeling, prototyping, and testing the Infrastructure as a Service right away.

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<sup>1</sup> A Whitepaper on the Tiered Logging Requirements for the Smart Grid

A convenient organization for the private cloud services that could be operated inside the Tier-2 Cluster Node might use the familiar CloudStack standard structure for the computing operations<sup>2</sup>. CloudStack is the current model for distributed cloud computing chosen by BT for its distributed Cloud Compute offering, and we will use the BT facilities to immediately handle the configuration and accounting functions for this implementation of the CloudStack operation because we intend to operate the Agile Fractal Grid in multiple countries. The BT implementation of CloudStack allows us to piggyback on the fact that there will be very practical matters of differences in currency, taxation, and regulations such as GDPR, HIPA, and international law surrounding maintaining receivables data within the borders of each country served. Therefore, the CloudStack standard was an easy choice, and the existing services of BT Cloud Compute for configuration and accounting were very practical.

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<sup>2</sup> *Supplemental Whitepaper Detailing the Structure of CloudStack*